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EXAMINER
UMEZ ERONINI, LYNETTE T

ART UNIT	PAPER NUMBER
1765	10

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Applicati n No.	Applicant(s)	
	10/045,318	DEORNELLAS ET AL.	
	Examiner	Art Unit	
	Lynette T. Umez-Eronini	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspond nce address --

Peri d for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 42-56* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 42-56* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1 and 42-50 are rejected under 35 U.S.C. 102(b) as anticipated by Nulman et al. (US 4,496, 419).

Nulman teaches a technique for fine line patterning having vertical walls of line widths (same as applicant's critical dimensions) much smaller than one micrometer (column 2, lines 1-3) for use in the fabrication of submicron devices (column 2, lines 8-11). The method comprises: covering a substrate (workpiece) **12** with an aluminum film (same as applicant's hard mask) **14,** oxidation mask **16,** and resist **18** (column 4, lines 8-13, 21-22); oxidizing the surface of aluminum film **14** by O_2 plasma (column 3, lines 1-5) that produces surface layers of aluminum oxide (Al_2O_3 that is the same as applicant's oxide skin on the exposed surface of the hard mask) on the exposed surface portions of film **14** (column 5, lines 3-4); and the Al (same as applicant's hard mask) film serves as an etch mask for the underlying substrate, the pattern is transferred to that substrate by means of any suitable dry etching process such as . . . reactive ion etching (column 3, lines 18-23).

The above reads on:

A method for etching a pattern on a workpiece, comprising:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal, the hard mask further defining a pattern including at least one portion having a critical dimension;

exposing the hard mask to a stream of oxidizing gas in order to form an oxide skin on the exposed surface of the hard mask;

processing the workpiece in a reactor by exposing the entire hard mask to an etch. Since Nulman uses the same method and gases in processing a substrate (workpiece) in a reactor as that of the claimed invention, then using Nulman's method of processing the workpiece in a reactor by exposing the entire hard mask to an etch would inherently result whereby the layer is etched corresponding to the pattern of the hard mask, and the growth of layer during the etch is minimized in the portion of the layer corresponding to the critical dimension, **in claim 1**.

Nulman further teaches, "Oxidation is carried out by means on an O_2 plasma directed at the surface of the Al film, . . ." (column 3, lines 3-6). "Oxidation of the Al film significantly reduces its etch rate . . ." and " . . . the selectively oxidized Al film is anisotropically etched by using reactive ion etching procedures . . ." (column 3, lines 7-15), and "the Al film is to serve as an etch mask . . ." (column 3, lines 19-23), which reads on,

said selecting step includes selecting a workpiece having a hard mask, which hard mask comprises of one of titanium, aluminum, and tantalum, **in claim 42**;

exposing the hard mask to a stream of oxidizing gas in the reactor prior to said etch step (column 3, lines 3-6), in **claim 43**; and

exposing the hard mask to a stream of oxidizing gas oxidizes the surface of the hard mask, thereby slowing down an etch rate of the hard mask, **in claim 49**; and

said selecting step includes selecting a hard mask (1) on which has been or (2) on which can be developed at least one of an oxide, nitride fluoride, boride and carbide (column 2, line 53 – column 3, line 20), **in claim 50**. Since Nulman uses an Al etch mask, which is the same as applicant's hard mask, then using Nulman's Al etch mask in the same manner as in the claimed invention would inherently result in,

a hard mask, which is readily oxidizable, **in claim 47**; and

which is comprised of a metal with a low sputtering yield, **in claim 48**.

Nulman teaches, "First, the initial pattern is defined in a positive resist using a conventional lithographic process, . . . Second, the pattern thus formed in the positive resist is transferred to an oxidation mask which lies on top of a metal film" (column 2, lines 20-26), which reads on,

said selecting a step includes a selecting a workpiece with a lithographic layer covering the hard mask (column 2, lines 20-26), in **claim 46**.

Nulman teaches, " . . . Aluminum RIE using $SiCl_4$ may be carried out . . . (column 21-33). "Thus, for example, reactive ion etching of aluminum may be accomplished not only with $SiCl_4$, but with other etchants such as . . . BCl_2" [Note: BCl_2 should read BCl_3, which is the same as applicant's oxidizing gas], (column 6, line 38-41), which reads on,

exposing the hard mask to a stream of oxidizing gas occurs during said processing step, in **claim 44** and

exposing the hard mask to a stream of oxidizing gas wherein the oxidizing stream includes using an oxidizing stream comprising one of and any combination of oxygen, nitrogen, fluorine, boron, and carbon gas, in the reactor prior to or during said etch step, **in claim 45**.

3. Claims 51 and 52 are rejected under 35 U.S.C. 102(b) as being anticipated by Nulman ('419).

As pertaining to claim **51**, Nulman teaches,

fine line patterning having vertical walls of line widths (same as applicant's critical dimensions) much smaller than one micrometer (column 2, lines 1-3) for use in the fabrication of submicron devices (column 2, lines 8-11);

covering a substrate (workpiece) **12** with an aluminum film **14,** oxidation mask **16,** and resist **18** (column 4, lines 8-13, 21-22);

oxidizing the surface of aluminum film **14** by O_2 plasma (column 3, lines 1-5) produces surface layers of aluminum oxide (Al_2O_3, which is the same as applicant's oxide skin) on the exposed surface portions of film **14** (column 5; lines 3-5); and

the Al (same as applicant's hard mask) film serves as an etch mask for the underlying substrate, the pattern is transferred to that substrate by means of any suitable dry etching process such as . . . reactive ion etching (column 3, lines 18-23). The above reads on,

A method for etching a pattern on a workpiece, comprising:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal and defines a pattern including at least one portion having a critical dimension;

allowing the hard mask to react with etch process gases, the process gases including a stream of oxidizing gas to form an oxide skin on the exposed surface of the hard mask.

Nulman teaches, " . . . the Al (same as applicant's hard mask) film serves as an etch mask for the underlying substrate, the pattern is transferred to that substrate by means of any suitable dry etching process such as . . . reactive ion etching (column 3, lines 18-23) and " . . . Aluminum RIE using $SiCl_4$ may be carried out . . . (column 21-33). "Thus, for example, reactive ion etching of aluminum may be accomplished not only with $SiCl_4$, but with other etchants such as . . . BCl_2" [Note: BCl_2 should read BCl_3 that is the same as applicant's oxidizing gas], (column 6, line 38-41), which reads on,

processing the workpiece in a reactor by exposing the entire hard mask to an etch.

Nulman also teaches, "If the process is not stopped at the device of FIG. **7**, the next step is to use the pattern lines **32** as an etch mask for the underlying material of layer **12**, . . . This may be accomplished in the Mo-Ta-PtSi layer **12** by means of a CF_4 + O_2 RIE step . . ." (column 6, lines 1-8). "In a test of the foregoing process . . . , . . . scanning electron microscope views of 1500 Ă and 5000 Ă wide Al lines **32** produced in the metal film layer **14** . . . It is anticipated that the present invention will permit

patterning . . . with dimensions less than 1500 Ă, . . ." (column 6, lines 14-27), which reads on,

whereby the layer is etched corresponding to the pattern of the hard mask to an etch. Since Nulman uses the same method of depositing, oxidizing, patterning, and etching the same material overlying a layer to be etched as in the claimed invention, then using Nulman's method in the same manner as in the claimed invention would inherently result in the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.

As pertaining to claim 52, Nulman teaches oxidizing the surface of aluminum film **14** by O_2 plasma (column 3, lines 1-5) produces surface layers of aluminum oxide (mainly Al_2O_3) on the exposed surface portions of film **14** (column 5; lines 3-5), which reads on allowing the hard mask to react with etch process gases forms an oxide skin. Using Nulman's Al film as an etch mask in the same manner as in the claimed invention would inherently result in, an oxide skin having a lower sputtering yield than the hard mask.

4. Claims 53-56 are rejected under 35 U.S.C. 102(b) as being anticipated by Nulman ('419).

As pertaining to **claim 53**, Nulman teaches a method for etching a pattern on a workpiece. The method comprises: covering a substrate (workpiece) **12** with an aluminum film **14,** oxidation mask **16,** and resist **18** (column 4, lines 8-13, 21-22); oxidizing the surface of aluminum film **14** by O_2 plasma (column 3, lines 1-5) produces

surface layers of aluminum oxide (mainly Al_2O_3) on the exposed surface portions of film **14** (column 5, lines 3-4); and when the Al (same as applicant's hard mask) film serves as an etch mask for the underlying substrate, transferring the pattern to the substrate by means of any suitable dry etching process such as reactive ion etching (column 3, lines 18-23), which reads on,

processing the workpiece using process gases, the workpiece having a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal and defines a pattern.

Nulman teaches oxidizing the surface of aluminum film **14** by O_2 plasma (column 3, lines 1-5) produces surface layers of aluminum oxide on the exposed surface portions of film **14** (column 5; lines 3-5), which reads on,

allowing the hard mask to react with the etch process gases. Since Nulman uses the same method and same process gas in reacting the same material (Al film) as in the claimed invention, then using Nulman's method would inherently allow the hard mask to react with the etch process gases in order to lower at least one of the sputtering yield and erosion rate of the hard mask, whereby the layer is etched corresponding to the pattern of the hard mask being etched into the layer.

As pertaining to **claim 54**, Nulman teaches, ". . . fine line patterns having essentially vertical walls for linewidths (same as applicant's critical dimensions) much smaller than one micrometer . . ." (column 2, lines 1-3) and " . . . for use in the fabrication of submicron devices . . . (column 2, lines 9-11). "If the process is not

stopped at the device of FIG. **7**, the next step is to use the pattern lines **32** as an etch mask for the underlying material of layer **12**, . . . This may be accomplished in the Mo-Ta-PtSi layer **12** by means of a CF_4 + O_2 RIE step . . . " (column 6, lines 1-8), which reads on,

the hard mask further defines a pattern including at least one portion having a critical dimension;

Nulman also teaches, "In a test of the foregoing process . . . , . . . scanning electron microscope views of 1500Ă a and 5000 Ă wide Al lines **32** produced in the metal film layer **14** . . . It is anticipated that the present invention will permit patterning . . . with dimensions less than 1500Ă, . . ." (column 6, lines 14-27), which reads on,

wherein the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension, **in claim 54**.

Nulman teaches, oxidizing the surface of aluminum film **14** by O_2 plasma [same as applicant's etch process gas] (column 3, lines 1-5) produces surface layers of aluminum oxide on the exposed surface portions of film **14,** as indicated at **30** (column 5; lines 3-5). " . . . the Al (same as applicant's hard mask) film serves as an etch mask for the underlying substrate, the pattern is transferred to that substrate by means of any suitable dry etching process such as . . . reactive ion etching (column 3, lines 18-23). "Aluminum RIE using $SiCl_4$ may be carried out by means of a commercially available system . . ." (column 31-35). "Thus, for example, reactive ion etching of aluminum may be accomplished not only with $SiCl_4$, but with other etchants such as . .

. BCl_2" [Note: BCl_2 should read BCl_3 that is the same as applicant's oxidizing gas], (column 6, line 38-41), which reads on,

allowing the hard mask to react with etch process gases forms a skin on the hard mask, **in claim 55** and selecting a hard mask that will react with the etch process gases, **in claim 56**. Since Nulman's method of oxidizing the Al film results in forming Al_2O_3 on the hard mask surface, then using Nulman's method in the same manner as the claimed invention would inherently result in a skin on the hard mask that has a lower sputtering yield than the hard mask, in claim 55 and a hard mask that will react with the etch process gases in order to lower at least one of the sputtering yield and erosion rate of the hard mask, in claim 56.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynette T. Umez-Eronini whose telephone number is 703-306-9074. The examiner is normally unavailable reached on the First Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on 703-308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are 703-972-9310 for regular communications and 703-972-9311 for After Final communications.

Lynette T. Umez-Eronini

ltue
July 31, 2003